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ABSTRACT

Utilizing word problems relevant to the field of environmental health, this workbook presents a concept-oriented approach to competency development in 14 areas of basic mathematics: (1) the expression of numbers as figures and words; (2) the addition, subtraction, multiplication, and division of whole numbers, fractions, and decimals; (3) scientific notation; (4) ratios and proportions; (5) percents; (6) measurement; (7) the geometric concepts of perimeter, area, and volume; (8) the Pythagorean Theorem; (9) introductory trigonometry; (10) introductory algebra; (11) problem solving; (12) logarithms; (13) probability and statistics; and (14) graphs. For each competency area, the workbook presents a series of word problems designed to reinforce student learning and to demonstrate the practical applicability of the mathematical concepts to the situations faced in environmental health occupations. An answer key for the problems is appended. (JP)

PERSONAL ACHIEVEMENT

MATHEMATICS

Environmental Occupations

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CURRICULUM MATERIALS DEVELOPED

UNDER THE AUSPICES OF

FUND TO IMPROVE POST SECONDARY EDUCATION

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1977

The problems found in this booklet are not meant to instruct you in the field of Environmental Health. They are practices of the various mathematical concepts and are content oriented to help show the practicality of each concept.

Study each mathematical competency in the general learning packets before attempting these applied problems.

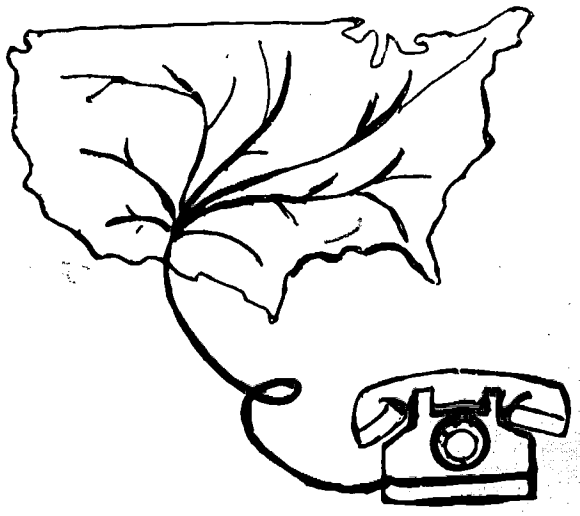
CONTENTS

INTEREST AREA: ENVIRONMENTAL HEALTH

Numeration

1. On Sunday, March 28, 1976 the population of our world reached the 4 billion mark. Write 4 billion and name each place value in the number.

2. In the United States today, a telephone can be connected to any 140 million other telephones. There would then be 10 quadrillion or 10 million billion possible connections. Write 10 quadrillion.



3. A single fly may carry as many as 6,500,000 microorganisms. Is this more or less than 6 million?

4. Rats cause an estimated nine hundred million dollars worth of damage to food supplies each year in the U.S. Write that dollar value using our decimal system.

5. In 1972 three billion, six hundred million metric tons of solid wastes were produced in the United States. Write that number being careful to note each place value.

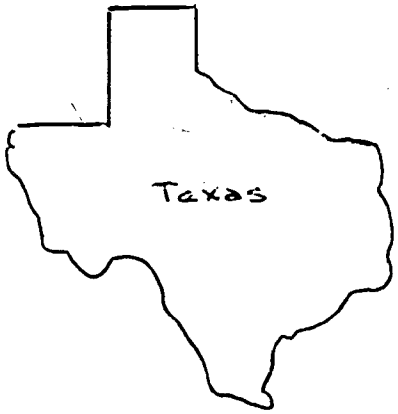
6. Noise pollution is a problem in urban areas. Noises are measured in units called decibels. A jet airplane taking off at close range measures about 150 decibels, while a jackhammer is slightly more than 100 decibels. If rock music at close range is about half way between those two measurements, give a number to approximate such a measurement.

7. The total kilowatt-hours of energy consumed in the United States in 1972 was 20,900,000,000,000. Write the words that you would say in reading that number.

Addition & Subtraction

1. The approximate water usage per cap/ per day varies in different cities. Chicago usage runs from 300-350, while Baltimore uses from 125-135. Taking the maximum for each, how much difference per person is that for a day?

2. Texas has more miles of highway than any other state. In 1970 it had 237,769 miles of roads, California had 162,809, Kansas 133,232, and Illinois, 128,479. What would be the total miles of road in these 4 states?



3. One study of water-borne diseases in the United States for 1946-1960 is reported in the table below:

# cases	Cause of water-borne disease
826	untreated surface water
8,811	untreated ground water
189	contamination of reservoir or cisterns
10,770	inadequate control of treatment
3,344	contamination of distribution system
1,194	contamination of collection or conduit systems
850	miscellaneous

How many total cases were reported in the study?

4. The area of New York State is 49,576 sq. miles and the state of Illinois is 56,400 sq. mi. How much larger is Illinois than New York?

5. The number of tons of solid waste generated from different sources in 1972 in the United States are listed below. How many total tons were generated that year?

SOURCE	
Municipal	297,080,000 tons
Manufacturing	127,320,000 tons
Mineral	1,315,450,000 tons
Agricultural	2,503,960,000

6. The 1971 Non-Foods sales in Grocery Stores make up the following accounts. Find the total for the ten categories.

Health & Beauty Aids	$ 3,023,000
Housewares	1,179,000
Soft Goods	49,000
Magazines, Books	301,000
Toys	163,000
Phonograph Records	88,000
Stationery	145,000
Sewing Needs	56,000
Miscellaneous and Seasonal Products	400,000

Multiplication

1. In building a new public swimming pool Bakersville allowed 36 sq. ft. for each adult swimmer. If the calculations were based on 375 adults in the water at one time, how many square feet would the swimming area have?

2. Small towns use an approximate average of 60 gallons of water per day per person. What would be the total daily need for a town of a population of 3954?

3. If the water usage for New York City is about 265 gallons per cap/ per day, how much would be used in one day, if the population was 7,895,563 in 1970?

4. Water storage for fire protection for a small town needs to produce a flow of 900 gallons per minute for 4 hours. If this entire amount is to come from the storage tank and not depend upon pumping from the town well, how large should the tank be?

5. In solid waste management it is found that compacted refuse weighed about 800 lbs. per cubic yard. If a refuse truck can carry 16 cu. yds., what weight of refuse would be in a full load?

6. A pound of ice in the process of melting absorbs 144 BTU of heat. How much heat would be absorbed by a ton (2000 lbs.) of ice?

7. If it takes 770 gallons of water to refine a 42 gallon barrel of petroleum and the United States uses some 8 million barrels per day, how many gallons of water would be used in refining each day?

8. A recommended size of a covered sand filter to serve a 3 bedroom private home is about 390 sq. ft. If it operates at a rate of 3 gallons per square foot per minute, how many gallons will pass through in one 24 hour day?

9. For every new person added to a community an average of 150 gallons of additional water will be needed each day. If a new housing development increased a city's population by 450, what additional amount of water will be needed each day? How much will that be in one year?

Division

1. Home water pressure tanks usually are a minimum size of 42 gallons or about 10 - 15 gallons per person. Would a 55 gallon tank be adequate for a family of 6?

2. In a small water system a well should supply about 500 gallons per hour. How many gallons per minute would this be?

3. Water usage in motels is approximately 40 gallons per bed. If the Lazy Way Motel has all two bed units and uses about 5000 gallons of water a day, approximately how many units are in the motel?

4. A water storage tank for a small town is completely emptied during a large fire. If the tank holds 216,000 gal. and the town well produces 200 gpm while the town uses 100 gpm, how many hours will it take to refill the tank?

5. If one wash basin is needed for every 10 - 15 girls in a summer camp, what would be the minimum and maximum numbers for a camp with approximately 100 campers?

Introduction To Fractions

1. If a person is on a low sodium diet (1000 mg per day) and their water intake gives them 50 mg each day, what fractional part of their daily allowance does this represent?

2. If a deck area around a public swimming pool slopes 3" in 12', what fraction would represent the amount of slope per foot?

3. A town has a total population of 12,960. Of this number 7200 have been vaccinated for small pox. What fractional part of the population does this represent? (Reduce the fractional answer to simplest terms.)

4. If 5 ounces of a disinfectant are added to 50 ounces of water, what fraction of the total mixture is disinfectant?

Fractions, + −

1. Garden hose used around a typical residence is usually either 3/4" or 5/8" in diameter. What is the difference in thickness between these 2 sizes?

2. The table at the right shows the number of gallons of water that different sizes of pipe will hold in a 100 foot length. How many total gallons will 100 feet of each of the three types hold?

Pipe Diameter	Gallons
1"	4 7/10
1½"	9 1/5
2"	16 3/10

3. A hydropneumatic tank is made of 3/16" steel and has an inside diameter of 22 1/2". What would be the outside diameter of the tank?

Multiplying Fractions

1. In a 2 compartment septic tank the first compartment contains 1/2 to 2/3 of the total volume. What would be the maximum volume of the first compartment of a 900 gallon tank?

2. In a public swimming pool it is estimated that 2/3 of the swimmers are in the pool at one time. If Carterville's pool had 360 swimmers at 2:00 one afternoon, approximately how many were not in the pool when a newsman took a picture for the "Daily News"?

3. If the slope of plumbing drains are usually 1/4 inch to the foot, what amount of drop, in inches, would there be in a drain line running 18 feet?

4. About 1½ gallons of water is needed each day for just physical subsistence , and not sanitation or other uses. What would be the minimum requirement for a city of 250,000 just for that purpose?

5. The suggested area for a community park is 1/4 acre per 1000 population. For a community of 32,600 how many acres are needed?

Dividing Fractions

1. One row of tile in the tile field of a residential septic system has a grade of 1/16" per foot. What is the length of this row of tile if the drop is 4 1/2"?

2. An estimate of the average hot water use in a restaurant is 1 1/2 gallons per person per meal. At this rate, how many meals can be served with a hot water supply of 500 gallons?

Decimals +, −

1. The chart below indicates the volume of water in 100 feet of varying diameters of pipe. Determine the total volume of water that would be contained in the pipelines involved in automated milking equipment if there are 300' of 1½" pipe, 500 feet of 2" pipe, and 200' of 1" pipe.

1"	1½"	2"
4.7 gal.	9.9 gal.	16.3 gal.

2. In 1970, 218.3 billion gallons of fresh water were used by industry each day. It is estimated that in 1980 394.2 billion will be needed. How much of an increase is that in the ten years?

3. If the rate of flow from household fixtures is measured in gallons per minute and varies dependent upon the type of fixture, how many gallons per minute (g.p.m.) will be flowing at once if the following units are in use:

   sink (4.5 gpm), shower (5.0 gpm), toilet (3.0 gpm), and a 5/8" 50' garden hose at (3.33 gpm)?

4. The preferred amount of fluoridation in public or private water supplies should be about .8 parts per million. How much over the preferred amount would a 1.7ppm be?

Multiplying Decimals

1. The cost of 8" pipe in a public water system is $1.50 more per foot than 6" pipe. How much additional cost will the use of 8" pipe add to the cost of 1 mile (5280 feet) of water line?

2. A supply of cast iron water pipe is on hand preparatory for laying water lines to a new subdivision. Calculate the value of 374 feet of 6" pipe at $6.40/ft. and 1260 feet of 8" pipe at $8.00/ft.

3. Annual solid waste production for beef cattle in feedlots is about 10.9 tons per head per year. If a farmer averages 320 head during a year, what would be the total solid waste per year for such a lot?

4. In a public swimming pool not less than 0.5 watts of underwater lighting per sq. ft. is standard. A pool with 2360 sq. ft. should have how many watts of underwater lighting?

5. Dressing rooms for a public swimming pool provide 7 square feet for each female and 3.5 square feet for each male patron. If the maximum expected use at any one period of time is 85 females and 120 males, how many total square feet of dressing room should be designed?

6. If a spray for chiggers takes 1/4 cup of 50% chlordan per gallon of water to cover 100 sq. feet, how much 50% chlordan is needed to spray a yard with 7500 sq. feet? Give your answer in cups.

7. In our New World population of 4 billion people about 2/3 of that number still does not have adequate safe water supplies. How many people does that represent?

8. If a water supply contains 20 mg of sodium per liter, and an average daily consumption of 2½ liters is assumed, how much sodium would be consumed through drinking water each day?

Dividing Decimals

1. Including private, public, and industrial uses of water, it is estimated that the total fresh water used in the United States each day in 1970 was approximately 411,000,000,000 gallons. If our population in 1970 was about 203,000,000 how many gallons of water per person does that represent?

2. In a city of 36,500 population the raw sewage sludge amounts to about 14.6 tons per day. How much per person per day does this represent?

3. If it is estimated that 477 gallons of hot water is used in a restaurant during one meal period and approximately 1.8 gallons are needed per customer meal, how many meals were served?

4. In calculating the required heat (BTU) for heating the water for a restaurant one formula that might be used gave the following:

$$BTU = \frac{181 \times 8.3 \times 150}{0.60}$$

Complete the multiplication and division to find the BTU heat per hour required.

Scientific Notation

A number is used in each of the following statements. Write the number in either scientific notation or in ordinary notation (the opposite of its existing form). Tell in each case the number of significant figures.

1. The area of the oceans of the earth is about 360,000,000 km^2.

2. The mass of an electron is .000,000,000,000,000,000,000,000,000,91 g.

3. The sun weighs about 4×10^{30} lbs.

4. The wavelength of a red light is about 0.000065 cm.

5. It takes about 5×10^4 lb. of water to grow one bushel of corn.

6. The transmitting frequency of one television channel is approximately 88,000,000 hertz.

7. A typical capacitor has a capacitance of 0.00005 farad.

8. Special boring machines can produce finishes to about 10^{-6} inches.

9. Some gamma rays have wavelengths of 5×10^{-11} cm.

10. Oil film on water is about 0.0000002" thick.

Ratio and Proportion

1. The slope of the bottom of the shallow water portion of a public swimming pool should be 1 foot in 15 feet. Write this as a ratio.

2. A chlorination dosage for 5 gallons of water is listed as 10 oz. of 70% hypochlorite, or 14 oz. of 50% hypochlorite. Write a proportion for these two dosages. Are they equivalent?

3. 65,000 gallons of water is needed to produce a ton of steel and 320,000 gallons are needed to produce a ton of aluminum. What is the ratio of water needed to produce steel to that needed to produce aluminum?

4. Cattle dip for ticks is made up of sodium carbonate, 24 lbs; arsenic trioxide 8 lbs; pine tar, 1-2 gallons; and enough water to make up to 500 gallons. If a farmer wishes to make a 200 gallon volume of dip, how many pounds of sodium carbonate should he use? Write a proportion and solve. Answer to 1 decimal place.

5. If slow type sand filters operate at the rate of about 2.5 million gallons per 160 square rods of filter area per day, how much will 96 square rods of this same type, filter per day? Answer to 1 decimal place.

Percent

1. In the cleaning of bottles in a dairy, a soaker tank type washer uses sodium hydroxide. Addition of 3/4 lb. of 76% commercial sodium hydroxide to 7 1/2 gal. of water will make a 1% solution. How much commercial sodium hydroxide would be needed to produce a 1.91% solution?

2. From 1964 to 1965 domestic air flight passenger numbers increased from 79 million to 92 million. What percent of increase does this represent?

3. In an urban planning agency, as much as 15 percent of man-hours or dollars goes for internal administration (correspondence, bookkeeping, meetings, etc.). In terms of a full 40 hour work-week, how many hours would be spent on this type of activity?

4. Federal grants are now available for cities to acquire developed land for urban parks, neighborhood centers, and other improvement projects. These grants are from 50 to 66 percent of the cost of the project. If a city had a $50,000 urban beautification project approved, what would be the maximum amount of dollar assistance they might expect?

5. In the cleaning of bottles in a dairy, a soaker tank type washer uses sodium hydroxide. If a 1.91% solution is needed at 140° for 3 minutes, what amount of sodium hydroxide is needed in 30 gallons of water to insure a high enough concentration? (1 gallon = 8.3 lbs.) Give your answer in pounds of sodium hydroxide.

6. An average amount of annual precipitation in the United States is about 30 inches, of which 72% evaporates, and 28% contributes to groundwater recharge and stream flow. What is the average number of inches that evaporate?

7. A septic tank of 900 gallon capacity was planned for the Parker's new residence. After further consideration they decided to add a garbage disposal which would require at least 30% more capacity for the septic tank. What is the minimum size tank that should then be specified?

8. Environmental reports concerning uninhabitable living units in Erie County, Pennsylvania note that 4.3% of their 77093 living units are below standard.

   If 605 of the substandard living units mentioned in the previous paragraph are inside city limits, what percent of the total uninhabitable units are in the city?

9. In food preparation establishments, it is estimated that the amount of hot water required per meal will average 1.8 gallons. (28% for food preparation, 55% dishwashing, 17% utensil and equipment cleaning). If a kitchen prepares 350 meals one day, what will be the approximate hot water use? How many gallons will be used for food preparation?

10. In a test for anticoagulant resistance in wild rats in Chicago, 54 rats were tested and 30 were found to be resistant. What percent of the rats tested were resistant?

11. The average total solids in Holstein milk is given as 12.2%. If 8.86% of this is non-fat solids, what percent would represent the fat solids?

12. Light whipping cream has a fat content of not less than 30% but less than 36%. If there are 70 lbs. of fat in a 200 lb. sample of cream, would this sample be classified as whipping cream?

Measurement

1. In plumbing drain lines bends of more than 22½° will cause a spiral type flow, which reduces the velocity of flow. If Mr. Hudson's helper started to lay out two lines which met at 30° how many degrees must he reduce the angle in order to join the lines at the preferred 22½ ?

2. An adult tapeworm in a fish can be over 30' in length. How long is this in meters?

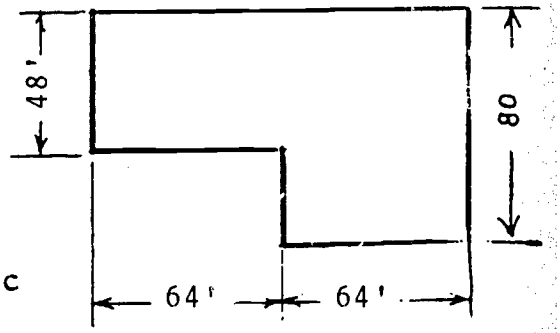
3. In emergency disinfection of small volumes of water, clorox can be used. 6 drops will treat 1 gallon of water. What part of a cup will be needed to disinfect 615 gallons? (1 liquid oz. = 615 drops.)

4. If 975 cu. ft. of sand is needed for the sand filter in a residential septic system, how many cubic yards should be ordered?

5. High density compacted refuse is about 66.5 lbs. per cu. ft. What would be the weight of a cu. yd. of refuse?

Perimeter

1. A public swimming pool is of the size and shape illustrated at the right. What would be its perimeter?



2. If gutter drains around the edge of a public swimming pool are located about 12 feet on center, how many drains will be needed for a pool 63' x 134'?

3. A circular holding tank for a water purification plant has a diameter of 20 feet. Find its circumference.

Area

1. A forest ranger can see 24 miles in all directions from his tower. How many square miles is he able to see?

2. One section of a rectangular swimming pool is three feet deep at one end and slopes uniformly one foot in fifteen feet to the other end. The length of the pool is 90'. What is the area of the concrete in the side of the pool?

3. A vent hood in a restaurant kitchen is 10' long and 4' wide. What is the area of the vent opening? If 100 cu. ft. of air is exchanged per minute per square foot of hood, how many cu. ft. of air will this vent hood exchange per minute?

4. Suppose the vent hood in the previous problem exhausts air through the exterior wall by means of a round vent with an exhaust fan. The fan could exhaust air at a rate of about 2000 cubic feet per square foot, per minute. Approximately what diameter round vent would be needed?

5. In one city a housing code requires a single light housekeeping room to have a minimum of 180 sq. ft. of habitable floor area. Give three examples of room sizes with approximately that area which would be adequate.

6. It is recommended that in any dwelling unit, 150 sq. ft. should be allowed for the first person and an additional 100 sq. ft. for each additional occupant. An apartment is 24' x 24'. What would be the maximum number in a family that should be allowed to live there?

7. How many square feet of concrete walk would be needed to surround a pool 49' x 100' , if the walk was to be 8' wide?

8. In a milking barn it is recommended that a ventilation window area of 4 sq. ft. per 60 sq. ft. of floor space be allowed. If the barn is 20' x 50', how many windows 2' x 3' will be needed?

9. How many circular air ducts 8" in diameter have approximately the same cross sectional area as a rectangular duct with dimensions of 24" x 36"?

10. An open dump is to be treated for rats. Bait should be applied at the rate of 1/4 lb. per sq. yard. If a dump is 300' by 600', how many pounds will be needed for the first application?

11. A "community" airport with two 2500 foot runways might require only 160 acres of space, while an intercontinental airport might occupy as much as eight square miles. What is the difference in area, in number of acres, between these two airport sizes?

12. The low land along a river is to be sprayed for mosquito control. The area is 300' wide by 5 miles long. If Paris green pellets at a rate of 15 lb/acre is to be used, how many pounds will be needed? (1 acre = 43,560 sq. ft.) (1 mile = 5280 feet)

13. A park is to be used for a Fourth of July celebration, and city officials want to take precautions to control chiggers. The area of the park where most of the crowd will be is half a mile long and 1/4 mile wide. Wettable sulphur is to be applied as a powder at the rate of 1 lb. per 1000 sq. ft. How much sulphur will be needed?

Volume

1. A combination sand trap and grease trap for a dairy plant is 2½' x 2½' x 8' and is adequate to handle 1000 gallons per hour flow. What volume of sand would such a trap contain?

2. In a public swimming pool the swimming area usually allows about 24 sq. ft. for each person. If the depth of such an area is 5 feet, what is the volume of water being allowed for each swimmer?

   If there is about 7½ gallons of water in a cubic foot, how many gallons of water would that volume represent?

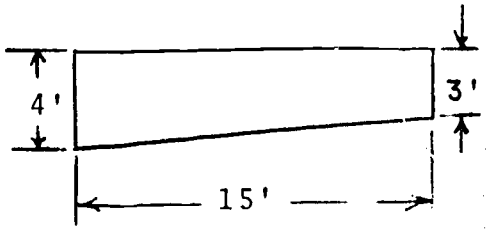
3. Dirt fill adequate for filling an undesirable area in your yard is $2.00 per cubic yard. How much would it cost to fill an area 9' x 12' which is 6' deep?

4. A swimming pool is 50' wide and 80' long. It is 3' deep at one end and 8' deep at the other end. Assume that the slope of the bottom is constant. How many gallons of water will the pool hold? (1 cu. ft. = 7½ gal.)

5. A bottle gas tank has a total length of 17 feet. The center section is a circular cylinder and each end is half of a sphere. Find the total volume of the tank if its diameter is 3 feet.

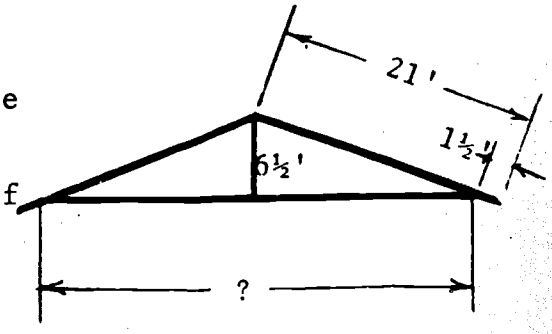
Pythagorean Theorem

1. The slope of a bottom of a swimming pool is not greater than 1 foot in 15 feet. where the water depth is less than 5½ ft. What would be the length of the sloping bottom of the pool in the figure at the right?



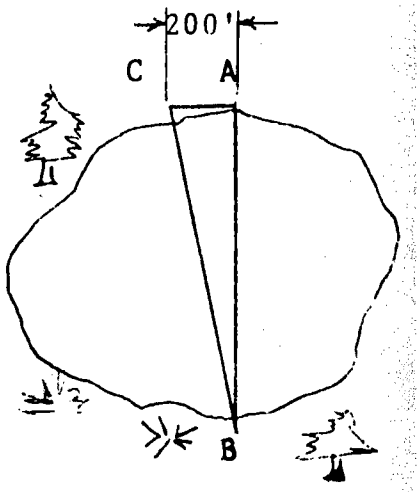
2. Floors in food processing plants, dairy plants, kitchens and similar places should have a trapped floor drain for every 400 sq. ft. of floor area with the length of travel to the drain not more than 15 feet.
If a drain is placed in the center of a room 12' x 30', is it adequate for the requirements stated above?

3. The rafters on the roof truss shown at the right are 21 feet long including a 1½ ft. over hang, and the height of the truss is 6½ feet as shown. Determine the length of the ceiling joist part of the truss.



Intro. To Trigonometry

USE TRIG. TABLES FROM A TEXTBOOK



1. A surveyor wishes to find the distance across a large lake. He sights a point B on the opposite side of the lake from point A. He then measures off 200 ft. from point A to point C so that CA is perpendicular to AB. He then determines that angle ABC is $8^\circ 50'$. How wide is the lake?

2. A forest ranger's tower is 2420 feet above most of the surrounding land and the tower itself is 80 feet tall. If the ranger sights a fire at an angle of 12° from the horizontal how far, to the nearest half-mile, is the fire from the tower?

3. A ladder on a fire truck can be extended to a maximum length of 68 feet when elevated to its maximum angle of 70°. The base of the ladder is mounted on a truck 7' above the ground. How high on a building will the ladder reach?

Introduction To Algebra

PART 1 Solve the following:

1. One engine has 2 hp more than a second engine and 3 hp less than a third engine. All three together have 16 hp. What is the power of each?

2. Oil tank A has a capacity of 100 gallons more than tank B. Tank C has a capacity twice that of B. The 3 tanks together have a capacity of 3100 gallons. What is the capacity of each tank?

3. Two cars, 598 miles apart start toward each other. One travels at the average rate of 50 mi/hr. and the other at 42 mi/hr. How many hours will it be before they meet?

4. How many quarts of pure alcohol must be added to 10 quarts of a solution which is 50% alcohol in order to make a solution which would be 70% alcohol?

5. An automobile has a 12 quart cooling system. If it is filled with a 25% alcohol solution, how many quarts must be drained off and replaced by pure alcohol to make the solution 60% alcohol?

6. Two large shipments of auto parts weigh 1800 lbs. The lighter shipment weighs 1/2 as much as the heavier. What is the weight of the heavier of the two shipments?

PART 2 Write a formula for each of the following.

1. Write a formula for the efficiency E of an engine if it is defined as the difference of the heat input I and the heat output P (I-P) divided by the heat input.

2. Write a formula for the volume of a rectangular gas tank if it is equal to the length (l) times its width (w) times its height (h).

3. The volume of a circular oil drum is calculated by multiplying the height (h) by half its diameter (d) twice and multiplying that product by 3.14. Write a formula as stated here or in a simpler form if possible.

4. Write a formula for the increase (L) in the length of a wire if it is equal to the difference in temperature [(t) before heating and (T) after heating] divided by 1000.

5. The current (I) in a circuit with a resistor (R) and a battery with voltage (E) and internal resistance (r) equals E divided by the sum of r and R.

6. To find the horsepower (H) of an electric motor multiply the number of volts (V) by the number of amperes (a) and divide by 746.

7. The amperage (A) of an electric circuit is equal to the wattage (W) divided by the voltage (V).

8. Profit (P) equals the margin (M) minus the overhead (O).

9. The speed (R) of a revolving wheel is proportioned to the number of revolutions (N) it makes in a given time (T).

PART 3 Each of the following formulas is used in technical areas. Solve each for the indicated letter.

1. $P = \frac{N + 2}{D}$ Mechanics: gears
Solve for N

2. $L = \pi (r_1 + r_2) + sd$ Mechanics: pulleys
Solve for r_1

3. $P = \frac{V_1 (V_2 - V_1)}{gJ}$ Jet engine power
Solve for J

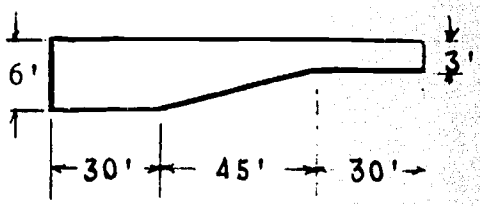
4. $Q_1 = P(Q_2 - Q_1)$ Refrigeration
Solve for Q_2

5. $P-Pa = dg\ (Y_2 - Y_1)$ Pressure guages
Solve for Y_2

6. $I = \frac{E}{r+R}$ Current
Solve for R

Problem Solving

1. Find the area of the side of a swimming pool shown at the right.



If the pool is 35' wide, what would be its volume in cubic feet?

What would be the volume in gallons needed to fill the pool? (1 cubic ft. = 7.5 gallons.)

2. If the brown rat produces 3 - 5 litters a year averaging 8 - 10 in each litter, with ½ surviving, what would you calculate to be the maximum number of offspring each female will produce each year?

3. A study of the Kansas Turnpike service areas showed that 20% of cars passing service areas will enter;; there will be 1½ restaurant customers per car; the average water usage will be 10 gallons per restaurant customer. If in one day 12,000 cars passed a certain service area, how much water can they expect to use?

4. The bottom of a septic tank which is 4' x 9' x 4' thick is to be reinforced in two directions with two 3/8" steel rods per foot of length and width. How many feet of rod will be needed?

5. Part I.
To avoid underground fires in sanitary land fills a limit of 200 tons in each refuse cell is recommended with a depth of 8 feet and 2 feet of compacted earth between each cell. If a cell were to be 20' x 85' x 8' and the weight of refuse is 800 lbs./yd^3 would this be below or above the 200 ton suggested limit?

Part II
How many cubic yards of earth would be above such a cell if the depth of 2' is used?

6. For swimming pools manufacturers recommend a gas chlorinator capacity of 15 lbs. for the first 100,000 gallons plus 10 lbs. for each additional 100,000 gallons of pool volume. A pool with a total volume of 250,000 gallons requires what chlorinator capacity?

7. The use of malatheon in aerial spraying for mosquitos dosage levels are 3 fl. oz. per acre. What would be the amount used over a swamp area of 2169 acres?

8. Aircraft which have been successfully spraying against mosquitos have normally flown at a speed of 150 mph at altitudes of 100-150 ft. above ground level producing a swath width of 300 to 500 ft. Approximately how many passes would be needed to spray an area one mile square?

9. Diazinon is used in some cases at the rate of 1 fl oz. (25% EC) to 1 gallon of water. The average application rate is about 10 gallons per 1000 sq. ft. and spraying is repeated every 10 days or less. At this rate, how many ounces of diazinon (25% EC) will be needed for 3 applications of 2500 sq. ft.?

10. A female rat becomes sexually mature in 2 to three months, produces about 20 surviving offspring per year. Starting with 1 female, what is the maximum number of rats that will exist after 3 years if half of all offspring are female and each lives 1 year?

11. If 100 gallons of Holstein milk with 3.4% butter fat is to be mixed with Guernsey milk with 4.95% butterfat, how much Guernsey must be added to bring the butterfat content up to 4% for the total mixture?

Logarithms

Use logarithms to evaluate each of the following:

1. $\dfrac{(\sqrt{56.9})\sqrt[3]{18.8}}{(17.8)^3}$

2. A numerical factor used in determining pressure losses, under certain conditions, equals $\dfrac{0.316}{\sqrt[4]{5000}}$. Calculate this factor.

3. Find the side of a cube whose volume is 893.4 cu. in.

4. The number of bacteria in a certain culture after t hours is given by:

   $N = (1000)10^{0.0451^t}$

   How many are present after three hours?

5. Find the intensity level of sound created by a riveter is it is found by the equation $B \text{ (in decibels)} = 10 \log \dfrac{10^{-6}}{10^{-16}}$

6. Under certain circumstances, the frequency of vibration (cycles/ second) in an electric circuit can be found by evaluating the following:

$$\frac{1}{(6.28)\left(\sqrt{0.000025}\right)}$$

Use logs to calculate.

7. The number of memory units of a certain computer is 2^{15}. Use logs to express that number in ordinary notation.

Probability & Statistics

1. "Garbage" weighs 800 to 1500 lbs. per cu. yd. What is its average weight?

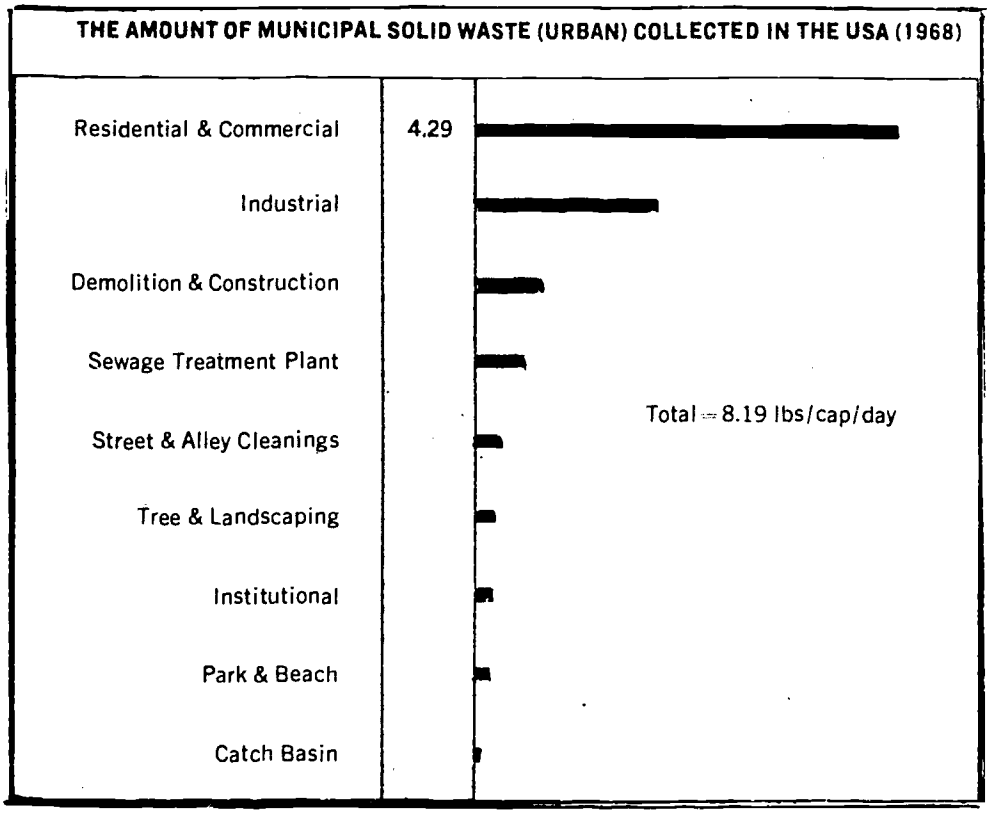
2. Today in the United States a telephone can be connected to any of 140 million others. How many possible connections would this represent?

3. If 5 different tests for the rate of ventilation were taken for a hood over a restaurant's steam tables and found to be 58, 64, 68, 60, and 55 cfm/ft^2, would the average be above or below a required 60 cfm/ft^2?

4. Chicago has spent more than $200 million of its own and federal monies in the past fifteen years on 41 urban renewal projects. On the average, how much does this represent for each project?

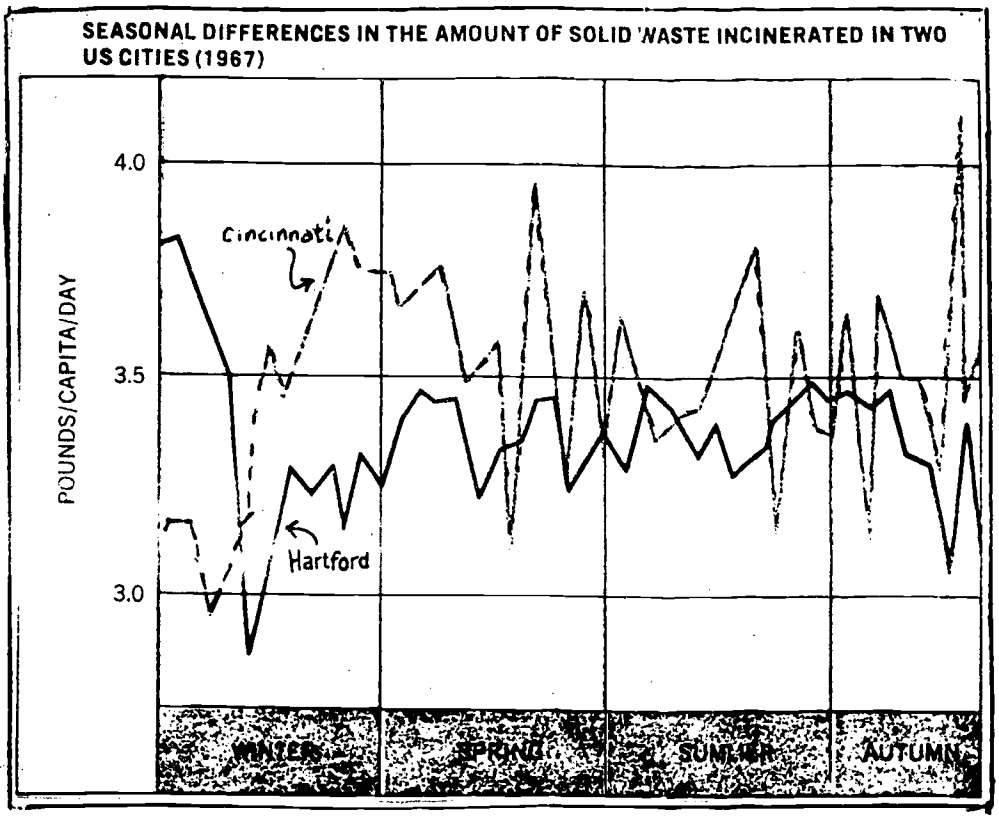
Graphs

1.



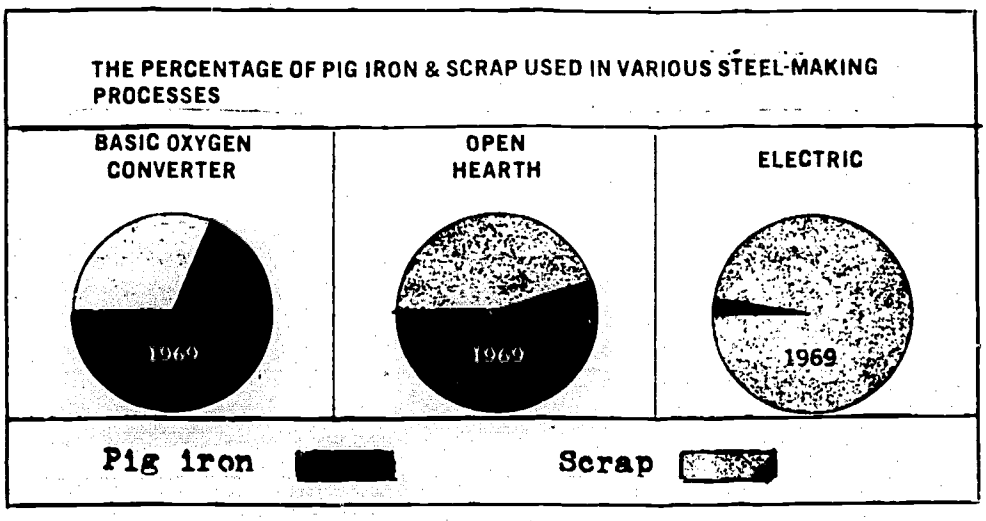
1. In the bar graph above the source and number of pounds per-capita per day of solid waste is given. Estimate the number of pounds per day per capita from Industrial and Sewage treatment plants.

2.



2. In the line graph above during what season is the largest amount of solid waste incinerated in Cincinnati? Estimate the number of pounds per-capita per day at that time.

3.



3. Use the circle graphs above to estimate the percent of pig iron and scrap used in each of the various steel making processes.